

4/24/02

**PATENT ABSTRACTS OF JAPAN**

(11) Publication number : 05-147975

(43) Date of publication of application : 15.06.1993

(51) Int.Cl.

C03C	13/00
C03B	37/01
C03C	3/08
C03C	3/087
C03C	3/091

(21) Application number : 03-335500

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(22) Date of filing : 26.11.1991

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**(54) HEAT RESISTANT GLASS FIBER****(57) Abstract:**

**PURPOSE:** To obtain a glass fiber having much more excellent heat resistance than an E glass fiber, capable of being easily produced with the E glass fiber as starting material and similar to the E glass fiber in physical properties except heat resistance.

**CONSTITUTION:** This heat resistant glass fiber has the practically same glass compsn. of borosilicate glass as an E glass fiber as a whole but only the surface layer is made of siliceous glass having  $\geq 80$ wt.% SiO<sub>2</sub> content.

**LEGAL STATUS**

[Date of request for examination] 19.05.1993

[Date of sending the examiner's decision of rejection] 12.09.1995

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

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**DETAILED DESCRIPTION**

[Detailed Description of the Invention]

[0001]

[Industrial Application] Though this invention is substantially [ as it of E glass fiber ] the same in the average glass presentation of the whole fiber, rather than E glass fiber, thermal resistance is notably excellent and is related with the suitable high temperature fiber glass for a heat insulator or an elevated-temperature electric insulation application.

[0002]

[Description of the Prior Art] E glass fiber was excellent in electric insulation or corrosion resistance, since tensile strength is also large, it is widely used for electric insulation lumber, a heat insulator, the reinforcement fiber for [ various ] fiber reinforced composite materials, etc. as most general glass fiber, and E glass fiber occupies most continuous glass fibers. The description on a presentation is for the content of alkali metal to consist of less than 1% of borosilicate glass so that it may be called alkali-free-glass fiber. Although the softening temperature of E glass fiber is about 845 degrees C, about 350 degrees C is usually the upper limit of usable temperature. At the temperature beyond it, since deformation takes place gradually in the practical use condition that a certain load is added and after cooling does not recover it, a mat-like thing will become an inelastic lump, for example. In E glass fiber, silica-alumina fiber is used for ceramic fiber and a general target in the field which runs short of thermal resistance. However, since ceramic fiber needs an advanced technique also for fibrosis highly [ the temperature when fibrosing the raw material ceramics to instead of / with more sufficient thermal resistance than a glass fiber ], it is very expensive compared with a glass fiber. And generally manufacture of a continuous fiber is difficult. Therefore, even if the thermal resistance of E glass fiber is inadequate, in the application which is not needed, the altitude thermal-resistance fiber of the thermal resistance like ceramic fiber which can be manufactured by refining of a glass fiber is more desirable than ceramic fiber. The heat-resistant fiber which can be replaced with ceramic fiber has a significant adverse effect to health also from a viewpoint which is going to reduce the amount of the ceramic fiber used which began to be pointed out in recent years. [0003]

[Problem(s) to be Solved by the Invention] Then, and it can manufacture this invention by using a glass fiber as a raw material, it aims at offering the high temperature fiber glass which shows the engine performance near ceramic fiber in thermal resistance.

[0004]

[Means for Solving the Problem] Although the high temperature fiber glass which succeeded in this invention providing has the same glass presentation substantially with E glass fiber as the whole fiber, the surface section is characterized by SiO<sub>2</sub> content consisting of 90% of the weight or more of nature glass of a silica preferably especially 85% of the weight or more 80% of the weight or more.

[0005] SiO<sub>2</sub> content of general E glass fiber is about 50 - 63 % of the weight, and since it is the thing of SiO<sub>2</sub> content to which the glass fiber of this invention is also substantially the same, namely, does not exceed at most 70 % of the weight with the above-mentioned E glass fiber as the whole average presentation, the surface section of the above-mentioned quality of a high silica exists clearly like a thin

lining layer in the glass fiber of this invention. However, although it does not necessarily have the clear two-layer structure where a presentation changes discontinuously from a fiber front face before a core part and there is SiO<sub>2</sub> content then rapidly toward the inside from a fiber front face, since it decreases continuously, when making an issue of SiO<sub>2</sub> content in this invention, the field from a fiber front face to a depth of 120A is called the surface section. Although the field of the quality of a high silica which having SiO<sub>2</sub> content higher than the core part of fiber can check by analysis is further extended from the above-mentioned surface section to a depth of hundreds of A thru/or about 1000A, even if it sees this whole nature field of a high silica, it is a narrow field also as used in the field of very thin "epidermis" in the ordinary glass fiber whose diameter of fiber is 10-micrometer (100,000A) extent.

[0006] Although especially components other than SiO<sub>2</sub> in the surface section are not limited, few [ as much as possible ] things are desirable, the component, for example, the B-2O<sub>3</sub> grade, which has an adverse effect in thermal resistance. It is as follows when the near content of the main constituents of the glass fiber by this invention is shown about the surface section and the whole fiber. The presentation of the general E glass fiber as a reference value is shown collectively.

Fiber surface section The average of the whole fiber E glass fiber SiO<sub>2</sub> (%) 80 or more 50-65 50-63 aluminum 2O<sub>3</sub> (%) Small quantity 10-16 12-16 B-2 O<sub>3</sub> (%) Small quantity 2-12 8-13 CaO+MgO (%) Small quantity 14-21 15-20 Na<sub>2</sub>O+K<sub>2</sub>O (%) Minute amount Minute amount Minute amount [0007]

[Function] Although the reason is not solved, the practical heat-resistant critical temperature of the glass fiber of this invention in which SiO<sub>2</sub> content has 80% of the weight or more of the surface section is more remarkably [ than that of E glass fiber ] high. For example, although it contracts quickly according to heat deformation of fiber at the temperature exceeding about 700 degrees C, the mat which consists of E glass fiber becomes a lump with a high consistency and it stops achieving the function as fire resistive covering material, some which consist of a glass fiber of this invention have even some which are equal to heating for 30 minutes at at least 900 degrees C, and equal to heating for 1050 degree C and 30 minutes. Although thermal resistance exceeds the level of the conventional glass fiber as mentioned above, the glass fiber of this invention is equivalent to E glass fiber in the physical properties and chemical property other than thermal resistance as it is expected from the average glass presentation of the whole fiber.

[0007] As for the average glass presentation of the whole fiber, the nature surface layer of a silica is thick, and even if it has the surface layer of the quality of a high silica, and the core layer of E glass resemblance like the glass fiber of this invention, thereby, in the nature fiber of a high silica from which it of E glass fiber differs remarkably, although near and thermal resistance excel the glass fiber of this invention in the so-called silica fiber, there is no flexibility in it, and since tensile strength is still lower, processing of needle punch processing etc. cannot make it in presentation. Moreover, since it is easy to collapse easily, since some of features which E glass fiber -- we are anxious about the adverse effect to the health by raising dust -- has are lost, from the object of this invention, it separates from them.

[0008] The alkaline earth metal which carries out suitable time amount immersion of the E glass fiber into the water solution of an acid, and is near a fiber front face, alkali metal, an alumina, boron oxide, etc. can manufacture it easily only by rinsing and carrying out stoving, after the glass fiber of this invention makes components other than a silica eluted. that is , since osmosis of the acid to the inside will not be attain without elution of an accord to acid in order E glass which constitute raw material fiber be very precise and not to make acid permeate glass component take place from a fiber front face , but a component be elute in part , and the organization of the surface section become loose , the nature surface layer of a surely clear high silica be form of acid treatment , and the interior remain substantially with the E glass of a basis .

[0009] As an acid used for acid treatment, the hydrochloric acid is most suitable and, subsequently a nitric acid is suitable. Since the rate of dissolution of the fiber component in acid treatment changes with existence or extent of the concentration of the acid to be used, processing temperature, and churning etc., it is necessary to determine the suitable processing time experimentally but, and when using a hydrochloric acid with a% [ of concentration ] of about 9 - 12, and a temperature of about 40-70 degrees C, the glass fiber of this invention can be obtained by immersion processing of about 30 minutes -

several hours.

[0010]

[Example] The E glass fiber (continuous glass fiber of 9 micrometers of diameters of average fiber) by Nippon Electric Glass Co., Ltd. was immersed in the hydrochloric-acid water solution, and the glass fiber of this invention was manufactured. The amount used was made into the amount of 7 times of raw material fiber weight, using a thing with a thing with a% [ of concentration ] of 9, and a temperature of 40 degrees C or a% [ of concentration ] of 12, and a temperature of 70 degrees C as a hydrochloric-acid water solution. A glass presentation and thermal resistance of the fiber which changed various immersion time amount and was obtained, and raw material fiber are collectively shown in a table 1. In addition, the component analysis carried out with photoelectron spectroscopy equipment about the surface section, ground about the whole fiber, and the chemical analysis performed it. "Thermal resistance" shows the judgment result in the following trial.

[0011] Heat-resistance-test method: Fiber is put into a crucible, heat for 30 - 120 minutes at intervals of 50 degrees C in 900 degrees C - 1050 degrees C in an electric furnace, observe change of fiber, and judge thermal resistance on the following criteria.

O The ductility of fiber is maintained mostly.

O The ductility of fiber is lost halfway.

Although the configuration of \*\* fiber remains, ductility is almost lost.

\*\* fiber is welding and deforming.

x All fiber fuses and the whole sample has become one lump.

[0012]

[A table 1]

試料No.	①	②	③	④	⑤	⑥
塩酸濃度 (%)	9	9	9	12	12	原料
処理温度 (°C)	40	40	40	70	70	Eガラス
処理時間 (H)	4	12	24	1	3	繊維
分析結果 (%)						
SiO <sub>2</sub> (全体)	55.1	55.2	61.8	55.4	65.8	54.6
" (表層部)	90.0	91.5	93.9	91.1	93.5	
Al <sub>2</sub> O <sub>3</sub> (全体)	15.3	15.3	13.1	15.4	12.0	15.5
" (表層部)	3.9	3.4	2.7	3.5	2.6	
CaO+MgO(全体)	21.4	21.3	18.1	21.0	16.2	21.6
" (表層部)	2.9	2.1	1.8	2.5	2.3	
B <sub>2</sub> O <sub>3</sub> (全体)	8.2	8.2	7.0	8.2	6.0	8.3
" (表層部)	3.2	3.0	1.6	2.9	1.6	
耐熱性	900°C・30分	◎	◎	◎	◎	×
	950°C・30分	◎	◎	◎	◎	×
	1000°C・30分	○	○	○	○	×
	1050°C・30分	▲	△	△	◎	×

[0013] Moreover, the result of having investigated the glass presentation change in the direction of a core from the front face of the glass fiber of sample \*\* by the above-mentioned example of manufacture

at intervals of 30A is shown in drawing 1.

[0014]

[Effect of the Invention] As mentioned above, the glass fiber by this invention can manufacture E glass fiber easily as a raw material, and, moreover, shows the outstanding engine performance near ceramic fiber in thermal resistance. Therefore, since E glass fiber of thermal resistance is conventionally inadequate, it can be used in many fields which could not but use ceramic fiber, and a big contribution can be made to the improvement of cost reductions, such as fire proof protection, and environmental sanitation in a building.

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CLAIMS

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[Claim(s)]

[Claim 1] It is high temperature fiber glass to which the surface section is characterized by SiO<sub>2</sub> content consisting of 80% of the weight or more of nature glass of a silica although it has the same glass presentation substantially with E glass fiber as the whole fiber.

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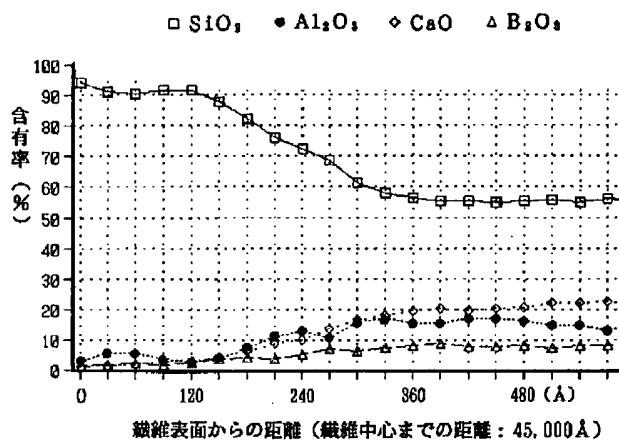
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